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EVALUATION OF JOINTS FABRICATED FROM CRES 310

55E 389

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REVISIONS

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INTRODUCTION

It has been found that CRES 301 suffers a loss in fatigue strength at liquid hydrogen temperatures. These CRES 310 specimens were tested in an effort to find a material with better fatigue properties at -423°F.

OBJECTIVE

The objective of the test was to determine the static and fatigue properties of joints fabricated from CRES 310 alloy at room temperature, -320°F, and -423°F.

CONCLUSIONS

1. The ultimate tensile strength of the CRES 310 specimens increased an average of 26.6% from room temperature to -320°F, and 9.8% from -320°F to -423°F.

2. At -423°F, CRES 310 has an ultimate tensile strength of 275 KSI compared to Convair Astronautics Specification No. 71004 CRES 301 which has an ultimate tensile strength of 259 KSI at the same temperature.

3. CRES 310 butt welded splice joints had greater fatigue strength at -423°F than did production CRES 301 joints.

4. The spotwelded joint efficiency of CRES 310 was high at all temperatures.

TEST SPECIMENS

The specimens were made of CRES 310, 75% cold rolled, GA. .020, coil 44942, HT M 43631. The configuration of the specimens is shown in Figure 1. There are four rows of resistance spotwelds on each side of the buttweld. The outside (1st) row has seven equally spaced spotwelds. The spacing of the other rows is shown in Figure 1.

PROCEDURE

Nine tensile specimens and six fatigue specimens were tested. The nine tensile specimens consisted of three specimens to be tested at room temperature, three at -320°F, and three at -423°F. The six fatigue specimens consisted of three specimens to be tested at -320°F, and three at -423°F.

The tensile and fatigue specimens to be tested at -320°F were placed in a tank which was filled with liquid nitrogen. The test sections of the tensile and fatigue specimens to be tested at -423°F were placed in a vacuum jacketed liquid hydrogen container. The vacuum jacket was then placed in a liquid nitrogen tank to reduce heat loss.

A hydraulic ram applied both tensile ultimate and fatigue loads. The piston area of the ram was 10.2 sq. in. Pressures were read on a Heise test gage. The tensile test strain rate was .001 inches/inch/min. to yield. The cycling stress levels were 0 to 140,000 psi and were applied at a rate of 6 cycles/minute. The number of cycles required to produce a leak and the number of cycles to failure were recorded. The specimens that survived 2000 cycles, were static loaded to failure after 2000 cycles.

Friction of the system was determined to be 25 psi. The details of the test apparatus are described in test report 7 E 2149 and 7 E 2379.

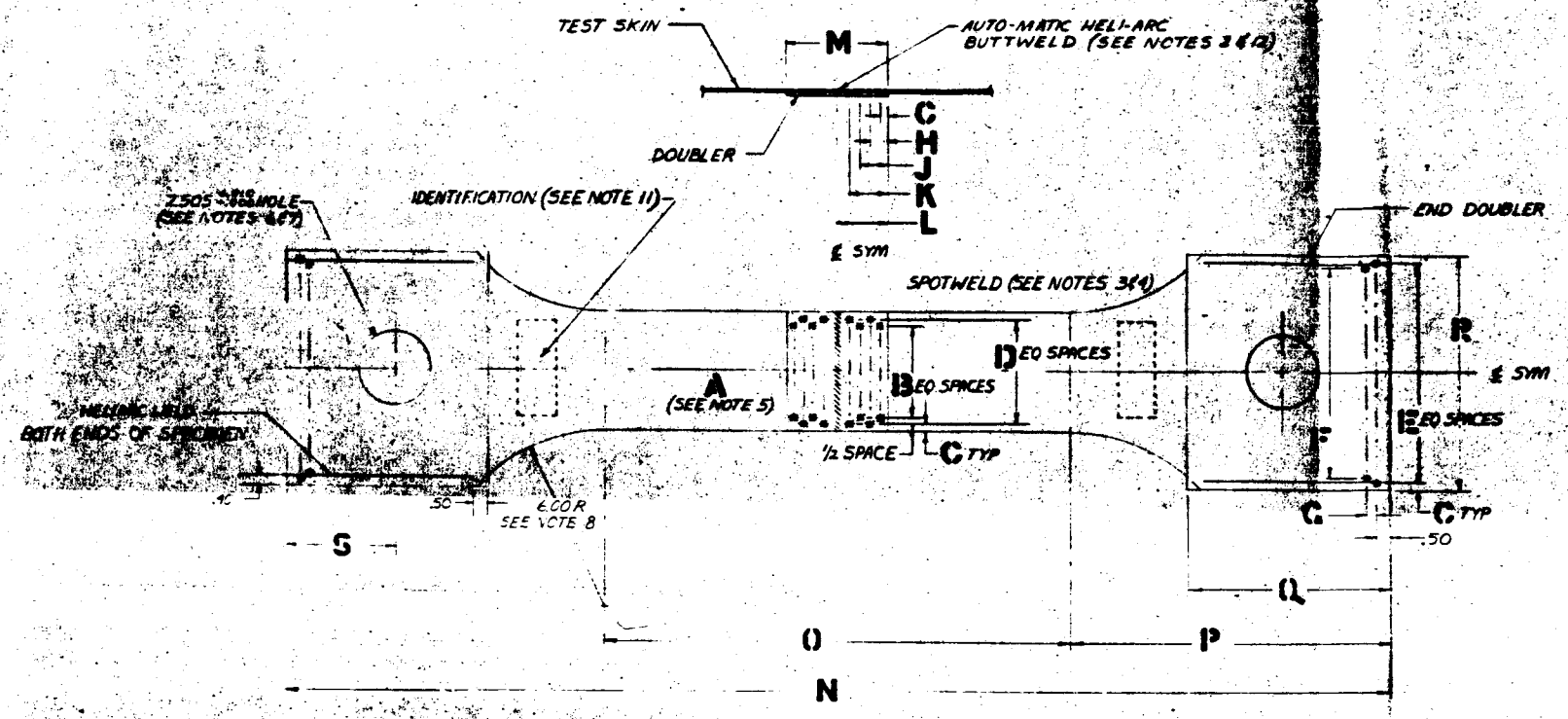
RESULTS AND DISCUSSION

The results of the static test are shown in Figure 2. The results of the fatigue test are shown in Figure 3. Figure 4 compares the results of a previous test with 9" coupons to this test with 38" specimens, and gives the joint efficiency.

Figure 5 compares the ultimate tensile strength of CRES 301 at room temperature, -320°F, and -423°F. It can be seen that the ultimate tensile strength of CRES 310 is lower than the ultimate tensile strength of CRES 301 at room temperature approximately the same at -320°F, and higher at -423°F. Figure 5 also shows that while the ultimate tensile strength of CRES 301 increases very little from -320°F to -423°F, CRES 310 has a marked increase.

The results of the static tests as shown in Figure 2 indicate that CRES 310 has good welded joint strength at -423°F, as the failure occurred away from the weld.

Figure 4 also compares fatigue data of CRES 310 to CRES E.F.H. 301 at -320°F and -423°F. It can be seen that CRES 301 has greater fatigue strength than CRES 310 at -320°F, but that CRES 310 has a greater fatigue strength at -423°F. than CRES 301. The CRES 310 specimens cycled from 0-140,000 psi skin stress had only one leak in 2000 cycles.



ASSY	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q	R	S
-835	1.34	.5	.28	.6	.11	.10	.57	.65	1.02	.39	1.86	3.75	.38	.16	.11	.7	.8	3.75
-839	1.96	.5	.25	.6	.12	.11	.34	.59	.93	1.27	1.74	3.51	.38	.16	.11	.7	.8	3.75
-831	2.74	.5	.25	.6	.13	.12	.34	.59	.93	1.27	1.74	3.51	.38	.16	.11	.7	.8	3.75
-829	4.28	.6	.25	.7	.14	.13	.34	.59	.93	1.27	1.74	3.51	.38	.16	.11	.7	.8	3.75
-827	4.39	.6	.25	.7	.14	.13	.34	.59	.93	1.27	1.74	3.51	.38	.16	.11	.7	.8	3.75
-825	3.86	.7	.25	.8	.17	.16	.34	.59	.93	1.27	1.74	3.51	.38	.16	.11	.7	.8	3.75
-823	3.70	.7	.25	.8	.17	.16	.34	.59	.93	1.27	1.74	3.51	.38	.16	.11	.7	.8	3.75

12. HELI-ARC BUTTWELDS PER SPEC G-7500.
11. EACH SPECIMEN TO HAVE GAGE, COIL#, HEAT#, SPEC & SPECIMEN #.
10. EDGES OF TEST SKIN TO BE MACHINED TO ✓ FINISH.
9. MAT'L SPEC TO BE CALLED OUT WITH SPECIMEN REQUEST.
8. IN RADIUS NO NOTCHES OR UNDERCUTS PERMITTED.
7. HOLES TO BE CENTERED WITH TEST SECTION ±.015.
6. EDGES OF SKIN MUST BE SHARP AND FREE FROM BURRS.
5. TEST SECTION WIDTH MIN AT CENTER. TOTAL TAPER TO BE .010 FROM ONE END TO CENTER.
4. TOL ON LOCATION OF SPOTWELDS TO BE ±.06.
3. SPOTWELDS PER SPEC MIL-W-6858A.
2. BUTTWELD TEST SKINS PRIOR TO MACHINING.
1. METAL STAMPING OF PART'S NOT PERMITTED

NOTES—

REQUIREMENTS PER ASSY		PART NO	DESCRIPTION	STOCK SIZE	MATERIAL	MIL SPECIFICATION
4		-115	END DOUBLER	.023 × 7.0 × 8.0	301 FH	C-A 0-71005
1		-113	DOUBLER	.023 × 3.6 × 4.34	301 3/4 H	
2		-111	TEST SKIN	.023 × 8.0 × 4.0	" "	
4		-109	END DOUBLER	.032 × 7.0 × 8.0	301 FH	C-A 0-71005
1		-107	DOUBLER	.032 × 3.6 × 4.34	301 3/4 H	
2		-105	TEST SKIN	.032 × 8.0 × 4.0	" "	
4		-103	END DOUBLER	.064 × 7.0 × 8.0	301 FH	C-A 0-71005
1		-101	DOUBLER	.064 × 3.6 × 3.92	301 3/4 H	
2		-99	TEST SKIN	.064 × 8.0 × 4.0	" "	
4		-97	END DOUBLER	.020 × 7.0 × 8.0	301 FH	C-A 0-71005
1		-95	DOUBLER	.020 × 3.6 × 3.92	301 3/4 H	
2		-93	TEST SKIN	.020 × 8.0 × 4.0	" "	

REQUIREMENTS PER ASSY		PART NO	DESCRIPTION	STOCK SIZE	MATERIAL	MIL SPECIFICATION
4		-91	END DOUBLER	.020 × 7.0 × 8.0	301 FH	MIL-S-5059A
1		-89	DOUBLER	.020 × 3.6 × 4.34	301 1/2 H	
2		-87	TEST SKIN	.020 × 8.0 × 4.0	" "	
4		-85	END DOUBLER	.020 × 7.0 × 8.0	301 FH	C-A 0-71009
1		-83	DOUBLER	.020 × 3.6 × 3.86	301 XFH	
2		-81	TEST SKIN	.020 × 8.0 × 4.0	" "	
4		-79	END DOUBLER	.020 × 7.0 × 8.0	301 FH	C-A 0-71009
1		-77	DOUBLER	.020 × 3.6 × 3.70	301 XFH	
2		-75	TEST SKIN	.020 × 8.0 × 4.0	" "	

DWG RECORD NO	SERIAL NO	NEXT ASSY	USED ON

APPLICATION

TENSILE SPECIMEN
ASSY - LARGE

Figure 1

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SAN DIEGO CALIFORNIA

DWG J 7-07781

7-00004

FORM NO. A-702-1

FIGURE 2

EVALUATION OF JOINTS FABRICATED FROM CRES 310 TENSILE ULTIMATE TEST RESULTS

Specimen No.	Thickness	Width	Area x 10^{-2}	Ultimate Stress KSI	Temp.	Remarks
310-1	.0191	4.003	7.644	182.14	R.T.	Failed in first row of spotwelds
310-2	.0192	4.002	7.684	183.18	R.T.	Failed in first row of spotwelds
310-3	.0193	3.998	7.715	181.13	R.T.	Failed in first row of spotwelds
				AVG. 182.15		
310-4	.0192	3.998	7.676	247.82	-320	Failed in first row of spotwelds
310-5	.0194	4.004	7.767	246.89	-320	Failed in first row of spotwelds
310-6	.0192	3.996	7.672	249.28	-320	Failed in first row of spotwelds
				AVG. 248.33		
310-7	.0191	4.003	7.645	272.18	-423	Broke on radius
310-8	.0191	3.999	7.638	277.77	-423	Broke on radius
310-9	.0190	4.000	7.600	275.13	-423	Broke on both sides of doubler at spotwelds.
				AVG. 275.03		

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FIGURE 3

EVALUATION OF JOINTS FABRICATED FROM CRES 310 FATIGUE TEST RESULTS

Specimen No.	Thickness	Width	Area x 10^{-2}	Skin Stress PSI	Temp.	Cycles to Leak	No. of Leaks	Cycles To Failure	Ultimate Strength After 2000 Cycles	Remarks
310-10	.0193	4.003	7.726	0-140,000	-320°F	1200	1	1832		Fatigue Failure
310-11	.0193	3.998	7.716	0-140,000	-320°F	1400	1	(2000)	215.47	Static Failure
310-12	.0191	3.997	7.634	0-140,000	-320°F	1200	5	1877		Fatigue Failure
310-13	.0191	4.000	7.640	0-140,000	-423°F	None	None	(2000)	215.62	Static Failure
310-14	.0193	3.994	7.708	0-140,000	-423°F	2000	1	(2000)	203.13	Static Failure
310-15	.0194	4.000	7.760	0-140,000	-423°F	2000	1	(2000)	212.28	Static Failure

NOTE: ALL FAILURES OCCURRED IN THE SHEET AT THE FIRST ROW OF SPOTWELDS.

FIGURE 4

ULTIMATE TENSILE STRENGTH VALUES FROM 38" SPECIMENS
COMPARED TO 9" COUPONS OF CRES 310 MATERIAL

TEMPERATURE	AVERAGE ULTIMATE STRENGTH		
	38" Specimens	9" Coupons(*)	Joint Efficiency
1. Room Temp	182 KSI	181 KSI	100%
2. -320°F	248 KSI	251 KSI	98.8%
3. -423°F	275 KSI	290 KSI	94.8%

FATIGUE DATA COMPARISON OF CRES 310
TO CRES 301 AT -320°F AND -423°F

Note: Sheet fatigue stress values were 0 to 140,000 psi.

TEMPERATURE	CRES 310		CRES 301 **	
	First Leak	Failure	First Leak	Failure
-320°F	1267	1850	1786	3005
-423°F	2000 +	2000 +	433	663

(*) Data taken from MRG-132-1, Table 15 (longitudinal direction) same heat and coil as large specimens.

(**) Data taken from Materials Lab data sheets #417, #444 and #532

\+ Cycling was stopped before failure.

COMPARISON OF ULTIMATE TENSILE STRENGTH OF CRES 310 TO CRES 301 WITH 38" WELDED JOINT SPECIMENS

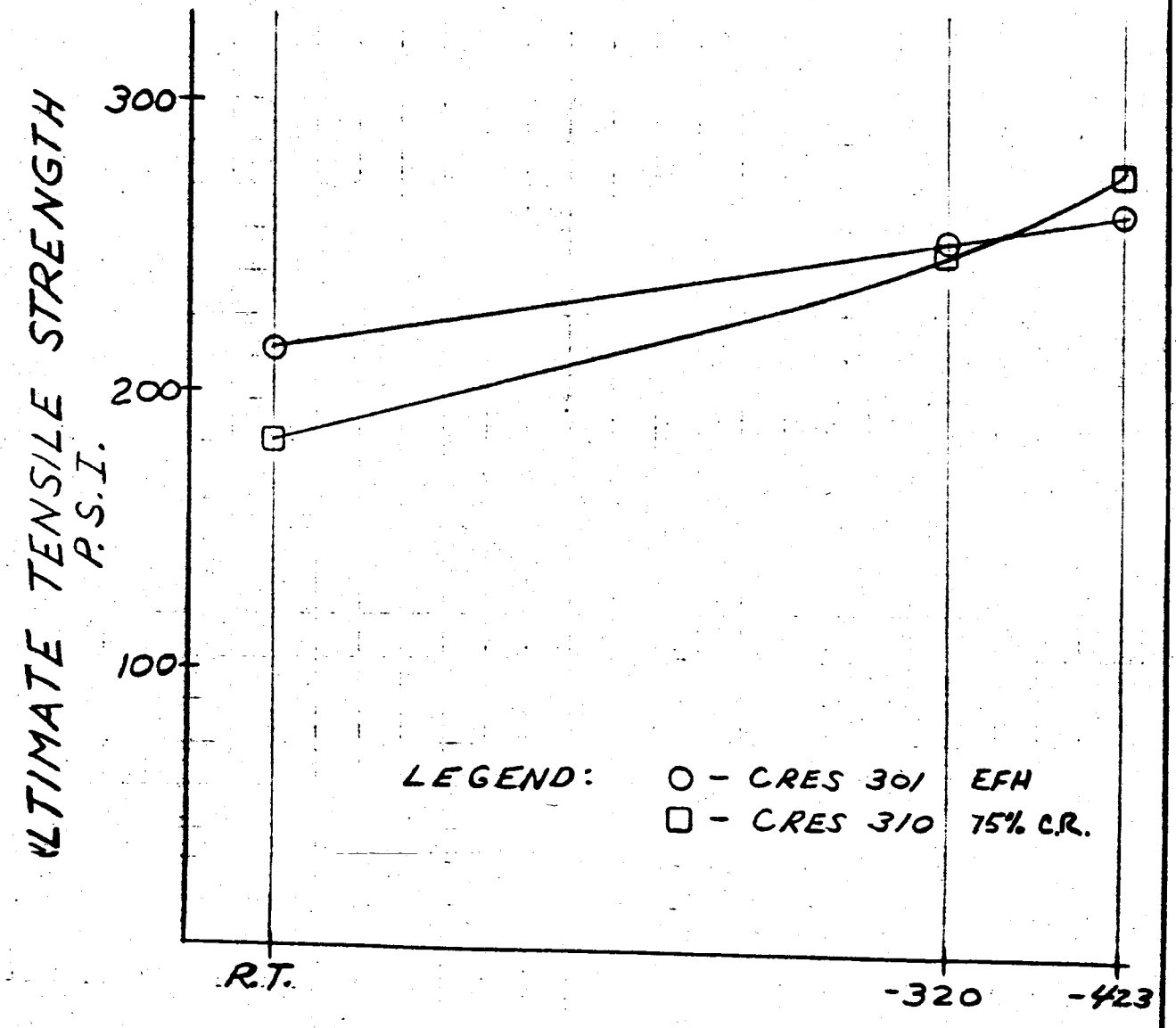

FIGURE 15

PREPARED BY	DATE	CHECKED BY	DATE	REVISED BY	DATE
S. ROTH	3-14-60				